Facial Recognition for Automatic Biometric Attendance System

[1]Atharva Patil, [2]Vaishnavi Pomendkar, [3]Vedant Raj, [4]Govind Wakure

[1,2,3]UG Student, [4]Professor, Department of Information Technology, MCT's Rajiv Gandhi Institute of Technology, Mumbai, Maharashtra, India.

[1]atharvap2000@gmail.com, [2]vaishnavipomendkar30@gmail.com, [3]vedant.raj02@gmail.com, [4]govind.wakure@mctrgit.ac.in

***Abstract*— In a developing country like India, the technological ecosystem is transforming in leaps and bounds. With this in mind, there is a need to automate the attendance system in various institutions. If we consider educational institutes then several strategies are seen to be used for managing and monitoring attendance of students. Most commonly the manual attendance marking roll numbers takes place, few institutes may even use finger print recognition system. While face recognition monitoring attendance systems are still not in mainstream, the potential is huge. The research that is conducted in Deep Learning, mainly in the neural networks domain provides significant opportunities in the future. An intelligent system which uses a friendly GUI with a strong facial recognition technology will save a lot of time and energy. Such a system can be built using the python language with Machine Learning Algorithms and a backend of MySQL database or an excel sheet. This paper proposes such a system using the De-facto standard GUI library of python i.e Tkinker Library, along with Python Cv2 library for face detection. Also using the Keras library, a Convolutional Neural Network is built which helps to identify or recognize the facial features of a person after detection of the face to mark the attendance. This system will automatically detect the person by their facial features and store the attendance in an excel sheet. In essence, this paper underlines the advancement in the Deep Learning through a practical everyday application.**

Keywords— Machine Learning, Face Recognition, CNN, Haarcascade, Softmax classifier.

I. INTRODUCTION

Attendance monitoring using conventional methods requires time and effort and sometimes may not be as efficient. Commonly used technical systems are Fingerprint recognition and RFID (Radio Frequency Identification) cards. A face recognition system offers more security than a fingerprint system as every person has facial features but not everyone has fingerprints. Face Recognition is also fast and secure. One of the key advantages of face recognition over other systems is that remote verification is possible. In the recent Covid-19 pandemic, it has become a necessity to have touch-less systems as precautions for safety purposes. In face recognition we do not have to touch the machine like in fingerprint scanners. The design of our system along with the experiment has been presented in this paper. In our system the student will have to first have to be registered into the database with his ID or roll number. For marking the attendance the student will have to face the camera, the inbuilt algorithm followed by image processing which will take place to match his/her face with the label(ID) stored in the database and if valid, their attendance will be marked.

This paper aims to present an intelligent system design which uses a framework called Keras to build a Convolutional Neural Network (CNN) to achieve the task of face recognition for biometric attendance system in an efficient manner. Facial feature detection is done by the haar cascade classifier, proposed by Paul Viola and Michael Jones in their paper, "Rapid Object Detection using a Boosted Cascade of Simple Features" [34]. Once the facial feature detection is performed by the classifier, the images captured are trained using CNN which uses Conv2D, POOL and Fully connected layers along with softmax classifier for training the image. After this process is completed the users can provide live feed to identify themselves. The real time images of the person are captured and then verified with the labels from the database to identify the person accurately.

In addition to real time attendance monitoring of students, this research has been aimed to make explore the latest Deep Learning techniques like CNN to reduce the drawbacks of

 DOI : 10.35291/2454-9150.2021.0128

earlier systems which used different algorithms like SVM or MLP. The results of the experiment are discussed in this paper..

II. LITERATURE SURVEY

This paper would be proposing the use of Deep Learning and Machine learning techniques for developing automated attendance marking system using Face Recognition. Many face recognition systems have been developed till date which make use of various algorithms and methodologies that attempt to replace and improvise the manual marking of attendance in order to enhance the functioning of educational institutions.

R. Alayham, Abbas Helmi, S. Salsabil bin Eddy Yusuf, A. Jamal and M. Irsyad Bin Abdullah in "Face Recognition Automatic Class Attendance System (FRACAS)"[1] have proposed the a face recognition system that makes use of Eigen-face as the primary algorithm along with multiple databases and overriding option to the administrator for managing the student attendance. The system aims to provide efficient attendance update and authenticity.

A. Khan. B, Jones. A.A, K. Kumar. N in "Modern Face Recognition with Deep Learning"[2] have proposed the use of Histogram of Oriented Gradients (HOG) technique for identifying the facial features. The system works by converting the obtained images into grayscale for detecting the features. Higher the number of training images, better the system accuracy. The system has also made use of OpenFace provided by python for face recognition under deep learning to address the factor of security.

Yogalakshmi.S, M. Leo.L, J. Simla.A in "Review on Digital Image Processing Techniques for Face Recognition"[3] have presented a review on various algorithms for face recognition that provide a sufficiently good accuracy. The algorithms included to be a part of the review were Geometric Based algorithm, Hidden Markov Model, Eigenface algorithm, Principle Component Analysis (PCA) along with ANN, face recognition using Artificial Neural Network, Template matching algorithm, Skin tone detection for face recognition by making use of Convolutional Neural Network and lighting compensation. The use and benefits of the algorithms mentioned above are stated and discussed respectively.

S. Bhattacharya, G. Sandeep Nainala, P. Das and A. Routray in "Smart Attendance Monitoring System (SAMS): A Face Recognition based Attendance System for Classroom Environment" [4] proposed a smart attendance system which includes the use of combination of certain algorithms for performing different tasks such detection of face from the given video input is done using the Viola & Jones idea of face tracker along with dlib library, extraction and normalization of facial features using image processing and Convolution Neural Network (CNN) for classification of the images.

E. Winarno, I. Husni Al Amin, H. Februariyanti in "Attendance System Based on Face Recognition System Using CNN-PCA Method and Real-time Camera" [8] have proposed a system making use of Convolutional Neural Network (CNN) and Principle Component Analysis (PCA) for face recognition. The system performs hybrid feature extraction by using the combination of CNN and PCA. CNN is used to convert 2D image into 3D image whereas PCA is used for extraction and dimension reduction.

Liyun Zhuang and Yepeng Guan in "Deep Learning for Face Recognition under Complex Illumination Conditions Based on Log-Gabor and LBP" [10] have proposed a methodology to deal with the problems arising due to complex light conditions in face recognition. The system uses Local Binary Pattern (LBP) for extracting features and Log-Gabor filter function for improvising image processing. The images which are now pre-processed are then sent to a Deep Belief Network (DBN) to generate the final output which is compared to the initial input for identification of a person.

Arjun Raj A, Mahammed Shoheb, Arvind K, Chethan K S in "Face Recognition Based Smart Attendance System" [12] have proposed a smart attendance marking system using Face Recognition which makes use of Raspberry Pi, Open CV and Dlib as basic requirements. The system uses LBPH for recognition and identification of a face in real time overcoming the drawbacks of using Eigenfaces and fisher faces which have high effects on due to light conditions. The systems stores the marked attendance in excel sheet and also includes providing the students an android mobile application for tracking their attendance.

S. Sawhney, K. Kacker,Samyak Jain, S. Narayan Singh, R. Garg in "Real-Time Smart Attendance System using Face Recognition Techniques"[18] have proposed a real time attendance management system making use of Face Recognition by using Viola & Jones for face detection, Principle Component Analysis (PCA) and Eigenface values and Convolutional Neural Network (CNN) for recognition. The system involves two databases, one with the student information and one for managing the attendance. A camera setup will be arranged outside the classroom which will be used for detecting the faces of the students, match with the student information database and update their attendance in the corresponding attendance management database.

T. Nyein and A. Nway Oo in "University Classroom Attendance System Using FaceNet and Support Vector Machine" [22] have proposed a system for classroom attendance for multiple face detection from one frame by using a combination of FaceNet and Support Vector Machine (SVM). FaceNet is being used for feature extraction and SVM for classification due to the easy to train factor.

D. Y. Liliana and I. M. Agus Setiawan in "Face Recognition with Kernel Principal Component Analysis and Support Vector Machine" [25] have discussed the functioning of face recognition strategies that involve Kernel Principle

 DOI : 10.35291/2454-9150.2021.0128

Component Analysis (KPCA) and Support Vector Machine (SVM) for identification. KPCA extracts features 2D input images and these features are performed classification upon by SVM for identifying a person.

III. Proposed System

The proposed system shown in Fig .1 includes generating a database including the images of all students in a batch as shown in Fig .2 where for each student the database will have 32 corresponding images in variation of conditions. These images will make the dataset which will be divided further into training dataset and testing dataset and will be sent through the Convolutional Neural Network (CNN). The training dataset will be used to train the model with some the images of all students in the dataset for each epoch (number of times the model has to be trained). Once trained with all the images, the model will notify the user through the GUI. Further for marking the attendance, the real time video capture feed is used as input by the model. It will detect the face and try to recognize it with the images in the dataset, if match found, it will update the respective student's attendance in an excel sheet and if no match is found, it will notify the user accordingly. The system provides a non-complex working for automatic attendance marking in a classroom environment along with exclusion of large storage.

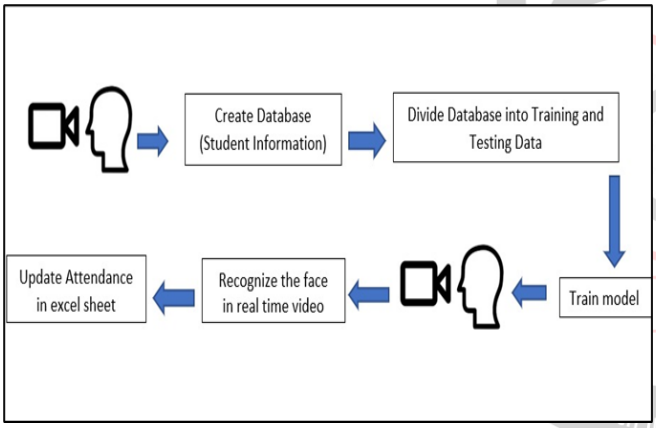

Fig. 1: Block Diagram of the Proposed System

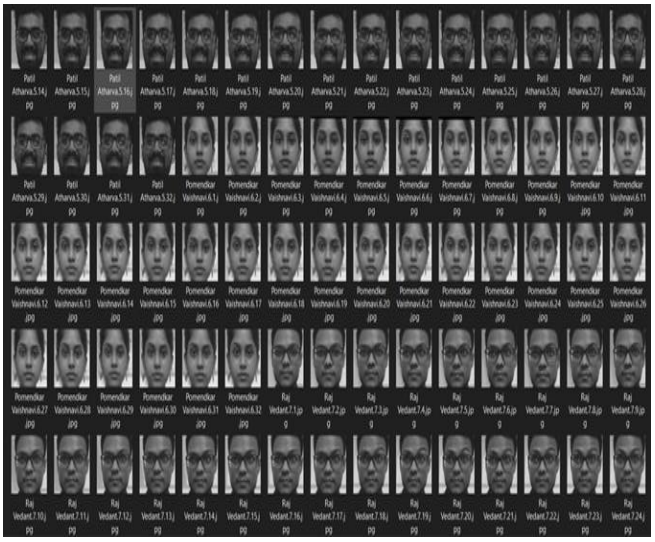

Fig. 2: Generated Dataset (Student Information)

The proposed system works as:

A. *Creating Dataset*

The dataset is created by using VideoCapture(0) function provided by Open CV giving video feed to the model and Haar Cascade frontal-face Classifier for face detection in real time. The model will take 32 frames of the video feed for each student, convert these images into grayscale and save them in a folder creating a dataset. The labels of these images in the dataset would be the name and ID of the student. (Fig 3)

B. *Training the model*

In order to train the model, the dataset is divided into training data of size 0.8 (80% of original dataset) and testing data of size 0.2(20% of original dataset). As of now, we have considered 10 epochs. For each epoch the data would be shuffled and will be randomly divided into the same ration of train and test data. Once all the epochs are completed, the GUI will prompt the user to inform that the model training has be completed successfully. (Fig 4).

C. *Face Recognition*

After training the model, when the attendance has to be marked, a student should stand in the frame of the camera and the model will take real time video capture as feed and compare the detected face in the frame with the images in the dataset. Convolutional Neural Network (CNN) recognizer will be used to perform this function. (Fig 5*)*

Updating the attendance

Once the model recognizes the face of a student, it will move ahead to update his/her attendance. It will extract the labels (names, ID) of the student from the dataset and append these labels along with the current time in the excel sheet which makes the attendance easy to view and manage. (Fig 6)

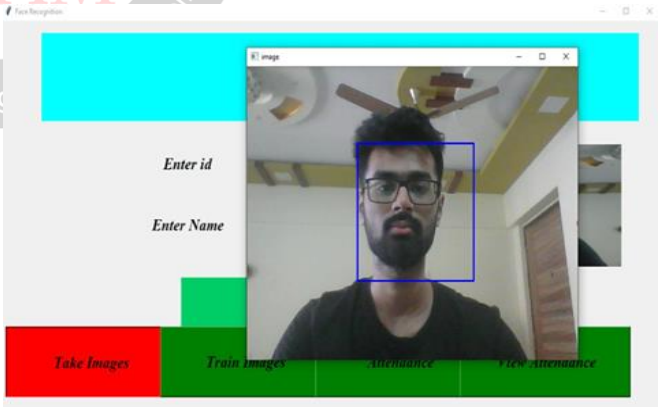

Fig 3: Creating Dataset by Taking Images

 DOI : 10.35291/2454-9150.2021.0128

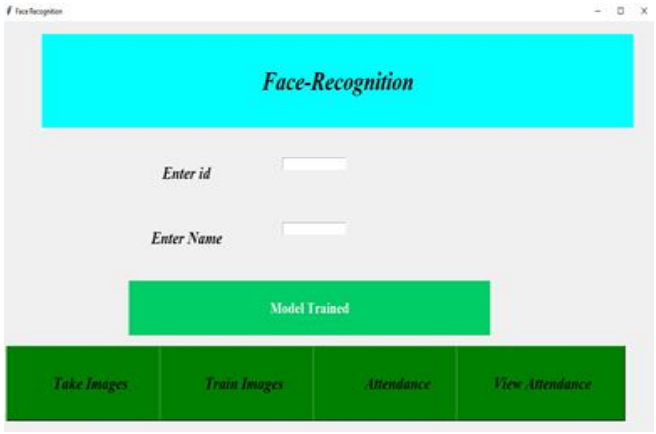

Fig 4: Training the model

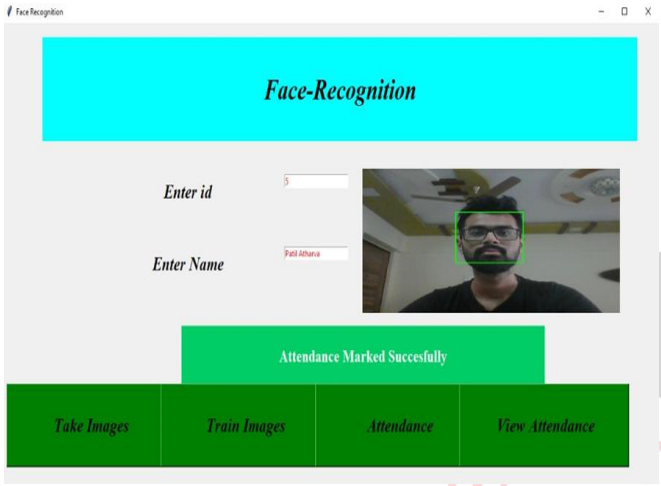

Fig 5: Face Recognition

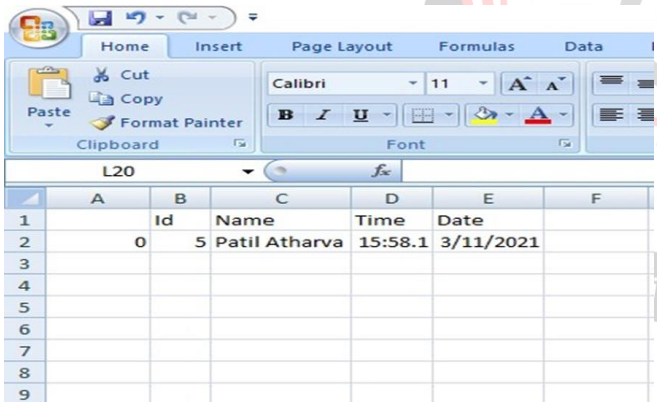

Fig 6: Updating the Attendance

IV. EXPERIMENT

While studying various papers on Face Recognition techniques we came across Radhika C. Damale[9] which had a detailed analysis of the widely used Machine Learning algorithms for Face Recognition. In this paper the performance evaluation of algorithms such as Support Vector Machine (SVM), Multi-Layer Perceptron (MLP) and Convolutional Neural Network (CNN) has been discussed. Both SVM and MLP are evaluated using Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) feature extraction techniques to obtain the accuracy.

The performance evaluation during cross validation accuracy showed that SVM resulted in 88% and 86% accuracy while using PCA and LDA respectively and MLP resulted in 86% and 87 % accuracy while using PCA and LDA respectively. But CNN on other hand resulted in 98% accuracy. The performance evaluation during real time testing accuracy showed that SVM resulted in 57% and 55% accuracy while using PCA and LDA respectively and MLP resulted in 55% and 57 % accuracy while using PCA and LDA respectively and CNN resulted in 89% accuracy. So in conclusion we understood that CNN has far superior accuracy than other widely used Machine Algorithms for Face Recognition.

After our detailed study of various papers on Face Recognition techniques we decided to choose Convolutional Neural Network (CNN) as the algorithm for our project. For our initial experiment we used the ORL dataset to test the accuracy of the CNN model that we had designed. We used Softmax classifier and Adam optimizer in our code with 250 epoch. The final accuracy we obtained was 94%.

Once our model was tested on a predefined ORL database we moved on to use it in our own database. The database we created was using OpenCV VideoCapture function to store it in a folder. Haar Cascade classifier was used for real-time face detection. Once the dataset was created by taking input from the users the dataset was trained using our model and was made ready for recognising faces. For this iteration of our model we used Softmax classifier and SGD optimizer. Every time the face is recognized it gets updated to an excel sheet for attendance.

V. RESULTS

For the final testing in order to obtain more accuracy of the CNN model live images of eight colleagues were taken. Thirty-two images of each person were captured and stored in a greyscale format in the database. For calculating the accuracy, a simple probability check was performed where the face recognition was run forty times on a random person from the database. Out of which each person was successfully recognized by the software thirty-eight times. So, the probability of recognizing a person is 0.95 which means the model is 95% accurate under suitable conditions. After a successful detection and recognition of a student the named and id of the student is updated in an Attendance Excel Sheet which also records the date and time when the attendance was taken. This result fairly complemented with the CNN model previously tested using the ORL database as well as the various papers referred on Convolutional Neural Networks.

Face Orientation	Detection Rate	Recognition Rate
0 degree	99%	99%
< 45 degrees	99%	99%
> 45 degrees	0%	0%

Table 1: Output of Face Detection and Face Recognition

 DOI : 10.35291/2454-9150.2021.0128

Fig. 7: Output of Face Recognition

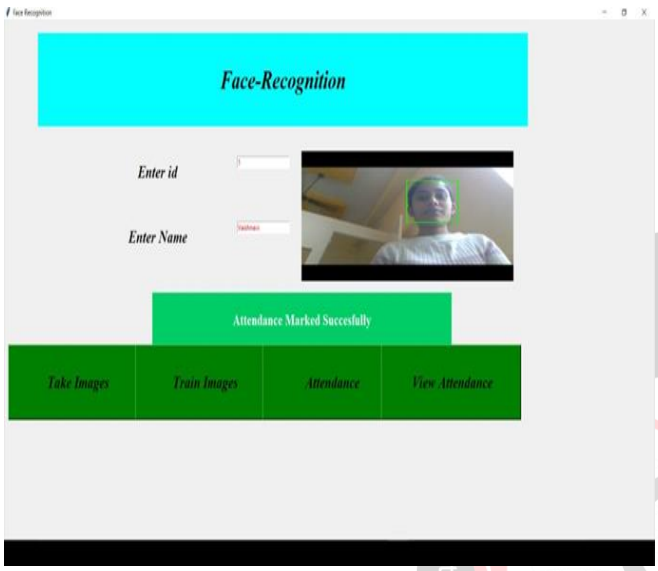

Fig. 8: Output of Face Recognition

VI. CONCLUSION

Using Convolutional Neural Network (CNN) has various advantages such as compared to its predecessors it automatically performs detection on the important features without any human supervision, that's the very reason we don't need a feature extraction algorithm alongside CNN unlike SVM and MLP which make use of either LDA and PCA. CNN works well under poor light conditions and are very effective in reducing the number of parameters without losing on the quality of models. Also CNN are better in recognizing the person at a variety of different angles. The only hindrance in using CNN is bigger the dataset more the computational power it requires. For effective face recognition in real time a good quality GPU like GTX 1070/1080 is required to process the live feed of images fed into the software. Along with a powerful GPU a good quality camera is also required for clear recognition. We are currently using a decent GPU (GTX 1060) and the default laptop camera (0.9 MP 16:9 (1280x720)) for our project and results are satisfactory.

This CNN model can be further improved in the future by tuning different parameters and adding various image augmentations like zoomed, sheared or rotated images which will not only increase the size of the database improving the accuracy, but also provide the CNN model with images of different orientation. Adding deeper network topology by increasing the layers of the Convolutional Neural Network will also result in an improved CNN model. With all the advancements, an efficient Attendance System using Face Recognition can be developed, which can be used on a daily basis in any Educational Institute.

REFERENCES

[1] R. Alayham Abbas Helmi, S. Salsabil bin Eddy Yusuf, A. Jamal and M. Irsyad Bin Abdullah "Face Recognition Automatic Class Attendance System (FRACAS)", 2019 IEEE International Conference on Automatic Control and Intelligent Systems (I2CACIS 2019), 29 June 2019, Selangor, Malaysia. ISBN:978-1-7281-0784-4.

[2] A. Khan. B, Jones. A.A, K. Kumar. N, "Modern Face Recognition with Deep Learning", 2018 Proceedings of the 2nd International Conference on Inventive Communication and Computational Technologies (ICICCT 2018) IEEE Xplore Compliant - Part Number: CFP18BAC-ART; ISBN:978-1-5386-1974-2.

[3] Yogalakshmi.S, M. Leo.L, J. Simla.A, "Review on Digital Image Processing Techniques for Face Recognition", 2020 International Conference on Communication and Signal Processing, July 28 - 30, 2020, India. ISBN: 978-1-7281-4988-2.

[4] S. Bhattacharya, G. Sandeep Nainala, P. Das and A. Routray, "Smart Attendance Monitoring System (SAMS): A Face Recognition based Attendance System for Classroom Environment" 2018 IEEE 18th International Conference on Advanced Learning Technologies. DOI 10.1109/ICALT.2018.00090.

[5] X. Qu, T. Wei, C. Peng, P. Du, "A Fast Face Recognition System Based On Deep Learning", 2018 11th International Symposium on Computational Intelligence and Design, 2473-3547, 2018, IEEEDOI 10.1109/ISCID.2018.00072.

[6] H. Sabu1, M. Sonawane, J. Patil, P. Vikhar, "Attendance System Based on Face Recognition", 2017 IJIRCCE Vol. 5, Issue 3, March 2017. DOI: 10.15680/IJIRCCE.2017. 0503159.

[7] Ms.Sarika Ashok Sovitkar "Comparative Study of Feature-based Algorithms and Classifiers in Face Recognition for Automated Attendance System", 2020 Proceedings of the Second International Conference on Innovative Mechanisms for Industry Applications (ICIMIA 2020) IEEE Xplore Part Number: CFP20K58-ART; ISBN: 978-1-7281-4167-1.

[8] E. Winarno, I. Husni Al Amin, H. Februariyanti "Attendance System Based on Face Recognition System Using CNN-PCA Method and Real-time Camera", 2019 International Seminar on Research of Information Technology and Intelligent Systems (ISRITI), 978-1-7281-4520-419, 2019, IEEE.

[9] R. C. Damale and Prof.Bageshree. V.Pathak , "Face Recognition Based Attendance System Using Machine Learning Algorithms", 2018 Proceedings of the Second International Conference on Intelligent Computing and Control Systems (ICICCS 2018) IEEE Xplore Compliant Part Number: CFP18K74-ART; ISBN:978-1-5386-2842-3.

[10] Liyun Zhuang and Yepeng Guan, "Deep Learning for Face Recognition under Complex Illumination Conditions Based on Log-Gabor and LBP", 2019 IEEE 3rd Information Technology,Networking,Electronic and Automation Control Conference (ITNEC 2019). ISBN: 978-1-5386-6243-4.

 DOI : 10.35291/2454-9150.2021.0128

[11] G. Singh and A. Kumar Goel, "Face Detection and Recognition System using Digital Image Processing", 2020 Proceedings of the Second International Conference on Innovative Mechanisms for Industry Applications (ICIMIA 2020) IEEE Xplore Part Number: CFP20K58-ART; ISBN: 978-1-7281-4167-1.

[12] Arjun Raj A, Mahammed Shoheb, Arvind K, Chethan K S, "Face Recognition Based Smart Attendance System", 2020 International Conference on Intelligent Engineering and Management (ICIEM). ISBN:978-1-7281-4097-1.

[13] C.B.Yuvaraj, M.Srikanth, V.Santhosh Kumar, Y.V.Srinivasa Murthy, and Shashidhar G. Koolagudi "An Approach to Maintain Attendance using Image Processing Techniques", 2017 Proceedings of 2017 Tenth International Conference on Contemporary Computing (IC3), 10-12 August 2017, Noida, India. ISBN: 978-1-5386-3077-8.

[14] A. Elmahmudi and H. Ugail, "Experiments on Deep Face Recognition using Partial Faces", 2018 International Conference on Cyberworlds. ISBN: 978-1-5386-7315-7.

[15] S. Shirsat, A. Naik, D. Tamse, J. Yadav, P. Shetgaonkar and S. Aswale, "Proposed System for Criminal Detection and Recognition on CCTV Data Using Cloud and Machine Learning", 2019 International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN). ISBN: 978-1-5386-9353-7.

[16] M. Coşkun, A. Uçar, Özal Yıldırım, Yakup Demir, "Face Recognition Based on Convolutional Neural Network", 2017 DOI: 10.1109/MEES.2017.8248937.

[17] Lin Zhi-heng*, Li Yong-zhen, "Design and Implementation of Classroom Attendance System Based on Video Face Recognition", 2019 International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS). ISBN: 978-1-7281-1307-4.

[18] S. Sawhney, K. Kacker,Samyak Jain, S. Narayan Singh, R. Garg, "Real-Time Smart Attendance System using Face Recognition Techniques", 2019 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence). ISBN: 978-1-5386-5933-5.

[19] O. Abdul Rhman Salim, R. Funke Olanrewaju, and W. Adebayo Balogun, "Class Attendance Management System Using Face Recognition", 2018 7th International Conference on Computer and Communication Engineering (ICCCE). ISBN: 978-1-5386-6992-1.

[20] J. D Souza W S, Jothi S, and Chandrasekar A, "Automated Attendance Marking and Management System by Facial Recognition Using Histogram", 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS). ISBN: 978-1-5386-9533-3.

[21] G. Yue and L. Lu, "Face recognition based on histogram equalization and convolution neural network", 2018 10th International Conference on Intelligent Human-Machine Systems and Cybernetics. ISBN: 978-1-5386-5836-9.

[22] T. Nyein and A. Nway Oo, "University Classroom Attendance System Using FaceNet and Support Vector Machine", 2019 International Conference on Advanced Information Technologies (ICAIT), Yangon, Myanmar, 2019, pp. 171-176, doi: 10.1109/AITC.2019.8921316.

[23] A. J. O'Toole, Yi Cheng, P. J. Phillips, B. Ross and H. A. Wild, "Face recognition algorithms as models of human face processing," Proceedings Fourth IEEE International Conference on Automatic Face and Gesture Recognition (Cat. No. PR00580), Grenoble, France, 2000, pp. 552-557, doi: 10.1109/AFGR.2000.840689.

[24] Riddhi Patel and Shruti B. Yagnik, "A Literature Survey on Face Recognition Techniques", 2013 International Journal of Computer Trends and Technology (IJCTT) – volume 5 number 4 –Nov 2013.ISSN: 2231-280

[25] D. Y. Liliana and I. M. Agus Setiawan, "Face Recognition with Kernel Principal Component Analysis and Support Vector Machine," 2019 International Conference on Informatics, Multimedia, Cyber and Information System (ICIMCIS), Jakarta, Indonesia, 2019, pp. 175-180, doi: 10.1109/ICIMCIS48181.2019.8985199.

[26] I. Mondal and S. Chatterjee, "Secure and Hassle-Free EVM Through Deep Learning Based Face Recognition," 2019 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COMITCon), Faridabad, India, 2019, pp. 109-113, doi: 10.1109/COMITCon.2019.8862263.

[27] V. Chawda, V. Arya, S. Pandey, Shristi and M. Valleti, "Unique Face Identification System using Machine Learning," 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2020, pp. 701-706, doi: 10.1109/ICIRCA48905.2020.9182981.

[28] S. Matilda & K. Shahin, "Student Attendance Monitoring System Using Image Processing". 2019 1-4. 10.1109/ICSCAN.2019.8878806.

[29] X. Tian and H. Long, "Research on Face Recognition Algorithm in Embedded System," 2019 2nd International Conference on Safety Produce Informatization (IICSPI), Chongqing, China, 2019, pp. 323-326, doi: 10.1109/IICSPI48186.2019.9096027.

[30] J. Harikrishnan, A. Sudarsan, A. Sadashiv and R. A. S. Ajai, "Vision-Face Recognition Attendance Monitoring System for Surveillance using Deep Learning Technology and Computer Vision," 2019 International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN), Vellore, India, 2019, pp. 1-5, doi: 10.1109/ViTECoN.2019.8899418.

[31] R. Hartanto and M. N. Adji, "Face Recognition for Attendance System Detection," 2018 10th International Conference on Information Technology and Electrical Engineering (ICITEE), Kuta, 2018, pp. 376-381, doi: 10.1109/ICITEED.2018.8534942.

[32] L. Hui and S. Yu-jie, "Research on face recognition algorithm based on improved convolution neural network," 2018 13th IEEE Conference on Industrial Electronics and Applications (ICIEA), Wuhan, 2018, pp. 2802-2805, doi: 10.1109/ICIEA.2018.8398186.

[33] W. Zeng, Q. Meng and R. Li, "Design of Intelligent Classroom Attendance System Based on Face Recognition," 2019 IEEE 3rd Information Technology, Networking, Electronic and Automation Control Conference (ITNEC), Chengdu, China, 2019, pp. 611-615, doi: 10.1109/ITNEC.2019. 8729496.

[34] Paul Viola, Michael Jones, "Rapid Object Detection using a Boosted Cascade of Simple Feature", Accepted Conference On Computer Vision And Pattern Recognition 2001

 DOI : 10.35291/2454-9150.2021.0128